Activity 9-1
The Nature of Organic Compounds

For each of the following paragraphs, numbered 1-6, choose words from the word list to fill in the blanks in that paragraph. Some lists group words that have contrasting meanings.

1. Origin and scope of organic chemistry

Word List

bonds	four	organic
carbon	living	petroleum
compounds	molecules	produced

Organic chemistry is the branch of chemistry that deals with the reactions and properties of the compounds of the element ___carbon___. In the early days, the term *organic* was applied to compounds found only in ___living___ organisms. It was widely believed that organic ___compounds___ could be ___produced___ only by plants or animals. However, in 1828 urea was produced from ammonium chloride and silver cyanate by Friedrich Wöhler as the first ___organic___ compounds to be synthesized in the laboratory. Earlier beliefs about the nature of ___organic___ compounds were discarded and except for a few kinds of compounds such as the oxides of carbon and the carbonates, all carbon compounds came to be considered as organic.

Today, organic chemistry is the largest and most important branch of chemistry. The work of most chemists deals with ___organic___ compounds. A very large number of organic compounds of many different types are known. This diversity exists because each carbon atom can form ___four___ covalent ___bonds___ with atoms of other elements and, more importantly, with other ___carbon___ atoms. There appears to be no upper limit to the number of ___carbon___ atoms that can be bonded together to form very large ___molecules___.

2. Characteristics of organic compounds

Word List

nonelectrolytes/electrolytes	positively/negatively	soluble
nonpolar/polar	organic	solvents

Molecules of organic compounds are generally nonpolar and tend to dissolve in nonpolar solvents. Most of these molecules are not very soluble in polar solvents such as water. However, some molecules such as ethyl alcohol and acetic acid are sufficiently polar to be soluble in water. Compared to the electrolytic properties of most inorganic compounds, most organic molecules are generally nonelectrolytes.

3. Boiling points and melting points of organic compounds

Word List

high/low	solids/liquids/gases
intermolecular	strong/weak
polar/nonpolar	

The molecules of some organic compounds are nonpolar or only slightly polar. Because of this, the intermolecular forces are weak. In the laboratory this characteristic is observed as relatively low melting points, low boiling points, low heats of vaporization, and high vapor pressures. At ordinary temperatures, most inorganic substances are generally solids, while many organic substances are liquids or gases.

4. The reaction rate of organic reactions

Word List

activated	faster/slower	ions
between/within	forces	rapidly/slowly
covalent/ionic	high/low	organic/inorganic

There is strong covalent bonding between atoms within organic molecules. In order to undergo chemical changes a significant amount of rearrangement of bonds is required. This, in turn, requires a high energy of activation. For these reasons, activated complexes, the intermediate structures in reaction mechanisms do not form readily. Thus, organic reactions take place more slowly than inorganic reactions. Inorganic reactions proceed at faster rates because the forces of attraction between positive and negative ions increase the likelihood of forming the activated complex.

5. Bonding in organic compounds

Word List

angle	molecular/ionic	tetrahedron
metals/nonmetals	share/transfer	four

In molecules of organic compounds, each carbon atom forms the equivalent of ___four___ bonds to other carbon atoms as well as other kinds of atoms. The ___four___ valence electrons of carbon can form ___four___ single covalent bonds. These bonds are directed toward the four corners of a regular ___tetrahedron___. The bond ___angle___ between any two of these bonds is 109°28′. This ___angle___ is sometimes called the tetrahedral angle. Adjacent carbon atoms can ___share___ one, two, or three pairs of electrons. Carbon atoms can also ___share___ one, two, or three pairs of electrons with atoms of other elements, usually other ___nonmetals___. The forces of attraction between organic molecules cause them to form ___molecular___ solids.

6. Classification of organic compounds

Word List

decreases	increment
chemical	intermolecular
homologous	number
increases	structures

Organic compounds can be classified into groups having similar molecular ___structures___ and similar ___chemical___ properties. Such groups are called ___homologous___ series. Each member of a ___homologous___ series differs from the preceding member by a common ___increment___. As members of a series increase in size of molecules and ___number___ of electrons, the strength of the ___intermolecular___ forces, primarily van der Waals forces, ___increases___. As the strength of these ___intermolecular___ forces increases, boiling point ___increases___, melting point ___increases___, and vapor pressure ___decreases___.

Activity 9-2
Hydrocarbons

1. What are the only two elements in a hydrocarbon? hydrogen and carbon

2. What is an aliphatic hydrocarbon? hydrocarbon with open chain structure – either straight or branched

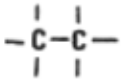
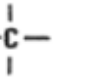
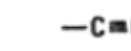
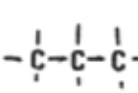
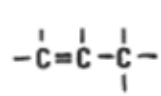
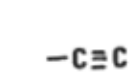
3. What is an aromatic hydrocarbon? any hydrocarbon that has at least one benzene ring

4. What is a homologous series of hydrocarbons? a series in which each member has the same general formula

5. How does the structural formula of one member of a homologous series of hydrocarbons differ from the next lower member? the higher member has an additional CH_2 group (called the increment)

Aliphatic hydrocarbons

Complete the following table to show the relationship between three homologous series of aliphatic hydrocarbons.

		Alkanes	Alkenes	Alkynes
6.	Other name(s) for series	paraffins methane series	olefins ethylene series	acetylene series
7.	General formula	C_nH_{2n+2}	C_nH_{2n}	C_nH_{2n-2}
8.	Series increment	CH_2	CH_2	CH_2
9.	Structural formula for characteristic carbon-carbon bond			
10.	Suffix for name	–ane	–ene	–yne
	Names and molecular formulas up to the 5-carbon member	(1) methane CH_4		
		(2) ethane C_2H_6	(2) ethene C_2H_4	(2) ethyne C_2H_2
		(3) propane C_3H_8	(3) propene C_3H_6	(3) propyne C_3H_4
		(4) butane C_4H_{10}	(4) butene C_4H_8	(4) butyne C_4H_6
		(5) pentane C_5H_{12}	(5) pentene C_5H_{10}	(5) pentyne C_5H_8
11.	Structural formula for 3-carbon member			

Aromatic hydrocarbons

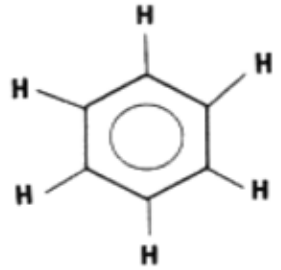
12. What is the general formula for the benzene series? C_nH_{2n-6}

13. What are the names and formulas for the first two members of the benzene series?
C_6H_6 – benzene; C_7H_8 or $C_6H_5CH_3$ – toluene

14. Members of the benzene series are aromatic (*aliphatic/aromatic*) hydrocarbons.

15. Why are members of the benzene series considered to be hydrocarbons? They contain only the elements carbon and hydrogen.

16. Draw a structural formula for benzene that shows its bonding structure as an average of single and double bonds.

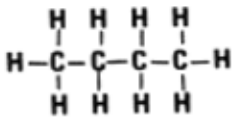


Isomers

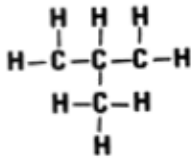
17. What are isomers? Compounds having the same molecular formula but different structural formulas, giving them different physical and chemical properties.

18. The simplest alkane that has isomers is butane. What is the molecular formula for butane?
C_4H_{10}

19. Draw structural formulas for the two isomers of butane. Label each with its IUPAC name.

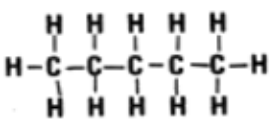


butane

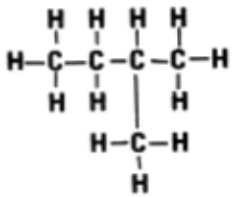


2-methylpropane

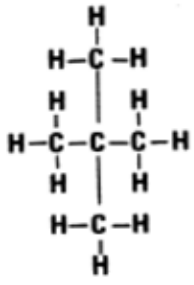
20. Draw structural formulas for the three isomers of pentane. Label each with its IUPAC name.



pentane



2-methylbutane



2,2-dimethylpropane

Petroleum

21. What is petroleum? a mixture consisting primarily of saturated hydrocarbons; it may also contain certain unsaturated hydrocarbons, aromatics, and sulfur and nitrogen derivatives

22. List six kinds of chemical products obtained from petroleum. gasoline, kerosene, diesel fuel, mineral oil, ____, propane, lubricating oil, home heating fuel, petroleum jelly, etc.

23. What properties permit the use of fractional distillation as a means to separate petroleum into useful components? The different useful components have different boiling points. As the temperature of the mixture reaches the b.p. of a particular component, that component leaves the mixture as a gas and is condensed and collected.

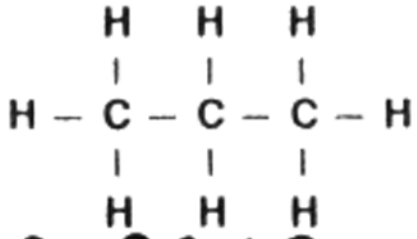
24. Describe the process of cracking as used in petroleum refining. A catalyst is used to break large molecules down into smaller molecules with lower boiling points.

NAMING HYDROCARBONS

Name _____

Name the compounds below according to the IUPAC naming system

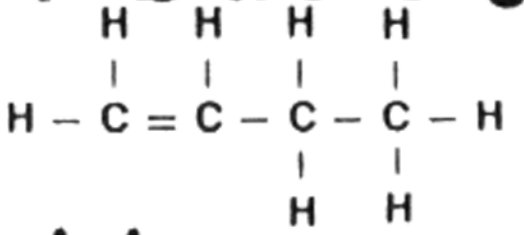
1.



propane

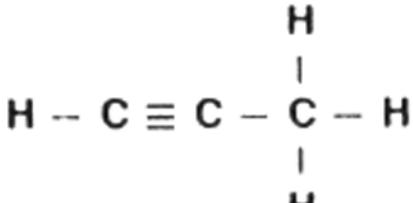
2.

n-butene or



1-butene

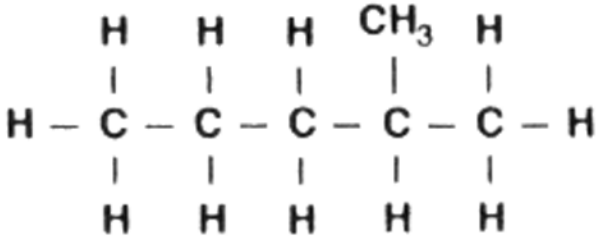
3.



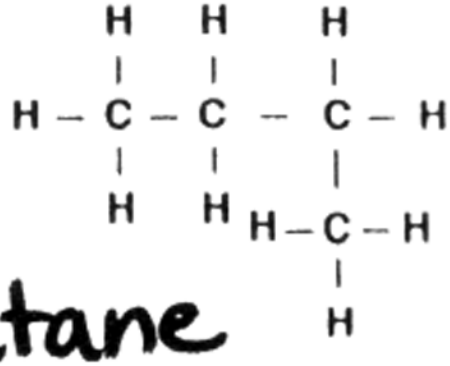
propyne

4.

2-methyl pentane



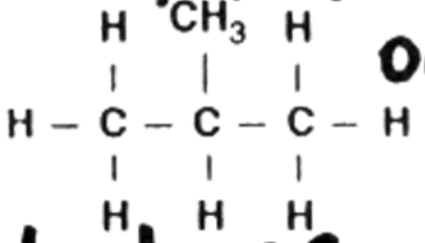
5.



butane

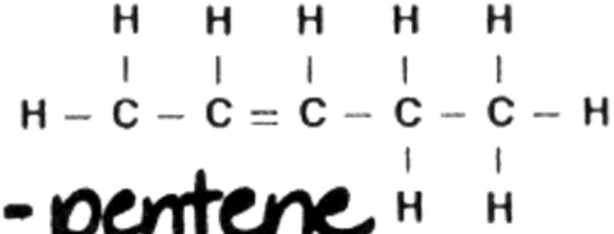
6.

Methyl propane or



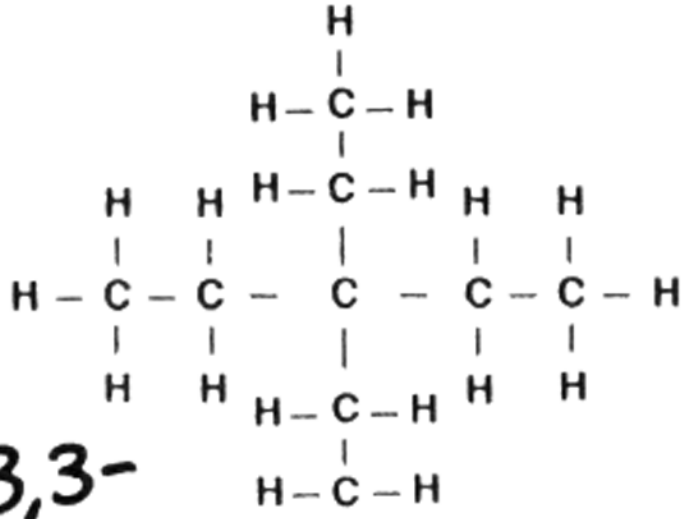
isobutane

7.



2-pentene

8.



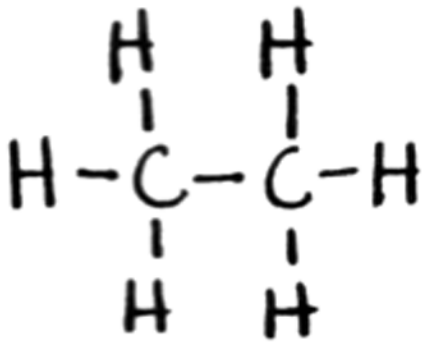
3,3-diethylpentane

STRUCTURE OF HYDROCARBONS

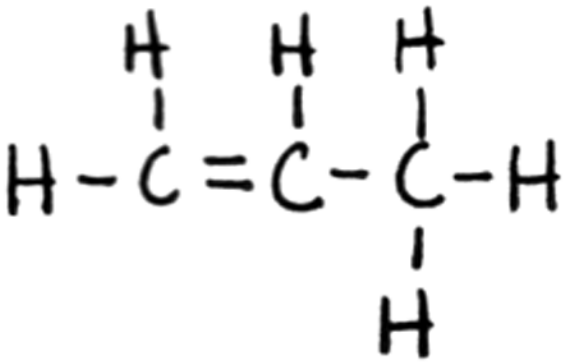
Name _____

Draw the structure of the compounds below.

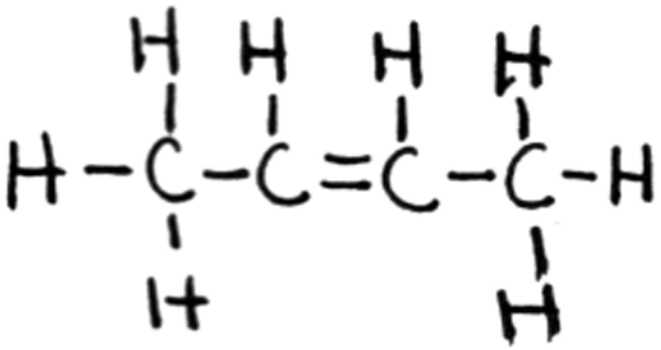
1. ethane



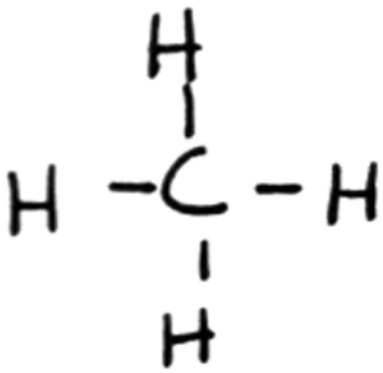
2. propene



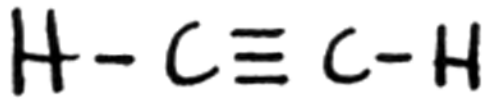
3. 2-butene



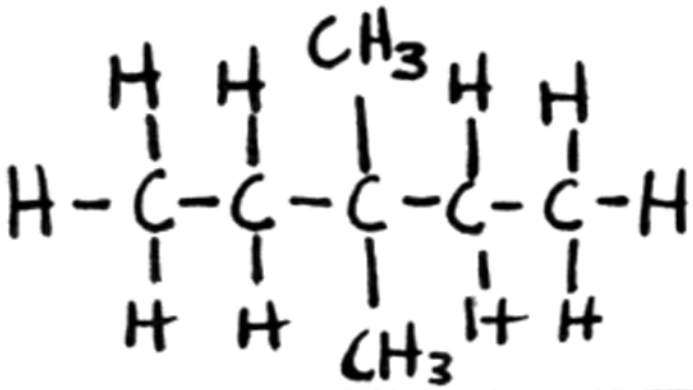
4. methane



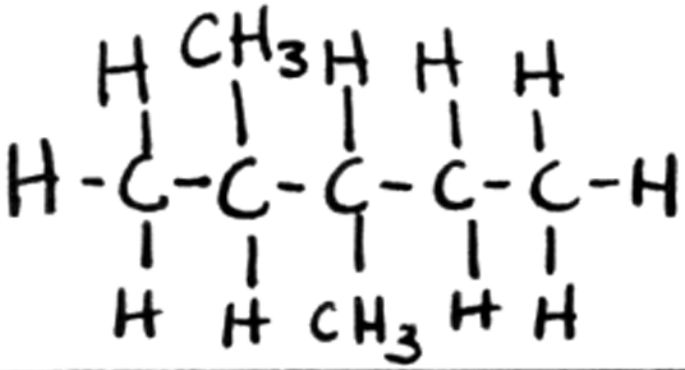
5. ethyne



6. 3, 3-dimethyl pentane



7. 2, 3-dimethyl pentane



8. n-butyne